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WHY PEOPLE MAY LIKE INVASIVE SPECIES: INVESTIGATING BIOPHILIA IN BOTANICAL GARDENS ADJACENT TO NATURAL FOREST ECOSYSTEMS

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Botanical gardens are considered as part of tropical invasion pathway. The extent of management effort to minimise plant invasion may be determined by the attitude of people managing botanical gardens. Social aspect may become a hindrance for invasive species management because people may like invasive species for certain reasons. Thus, there is a need to examine aspects that motivate affection of stakeholders for invasive species to minimise conflict of interest during management implementation. In this study, social perceptions of invasive species from four Indonesian botanical gardens were recorded. These botanical gardens are maintaining exotic collection and are situated next to native forests. The objectives of this study were to examine the dominant biophilia-based perception types exhibited by staff of botanical gardens in relation to exotic collections in their botanical gardens and whether these perceptions correlated with demographic factors. In general, dominionistic type dominated social perception of botanical garden staff. There were only minor variations across demographic factors. These findings indicated that inspiration to manage and curiosity to learn about exotic species were main motivations behind biophilia-based perceptions in Indonesian botanical gardens. This valuable information may enhance the strategies to minimise conflict of interests among stakeholders in the management implementation of invasive species.

Keywords: Forest management, conservation, exotic plant species, tropical forest, Likert scale

INTRODUCTION

Botanical gardens in tropical environments are potential sources of invasive species. The attitudes of those managing the gardens towards invasive species are important because they may determine the vigilance and the effort to minimise the invasion process. More broadly, the attitudes of the community towards invasive species may determine the success or failure of plans for the management of the species. While many ecologists assume implicitly that biological invasions are detrimental, ecological and social impacts of invasive exotic plant species are not always negative. For instance, exotic invasive plant species may provide temporary shade for early restoration stages (D'Antonio & Meyerson 2002). Exotic plant species are also considered to be important resources in several societies (Rai et al. 2012, Tassin & Kull 2015). Aside from the ecological perspective, socio-economic context also contribute to people's perceptions of exotic and invasive species (Dickman et al. 2015, Tassin & Kull 2015). Nevertheless, most conservation management priorities for biological invasion focus on negative impacts of exotic species only.

For certain regions or countries, exotic species tend to be a lower management priority (Kull et al. 2015). For example, there is less information available on exotic invasive species from South-East Asia (Peh 2010). This limited information may indicate the lack of resource in these areas, even though decision makers may realise the importance of invasive species issues. On the other hand, less information about these exotics may be due to varied perceptions (either positive or negative) of biological invasion from relevant stakeholders (including researchers, policy makers and social communities). Varied perceptions of the costs and benefits of biological invasions among stakeholders may erode common interest in the importance of invasive

species and impede concerted action. There is a need to clarify the perspectives and perceptions of biological invasion in neutral and objective ways, so that a clear map of the social affiliations and interests of stakeholders in management options may emerge (Larson 2007), resulting in clearer and socially acceptable management of invasive species. This clarification is important because social aspects contribute to both conservation problems and solutions (Machlis 1992), including invasive plants management.

Biophilia refers to innately emotional affiliation of human beings to other living organisms (Wilson 2007). Human attitudes to nature, including exotic invasive species, can be classified under the biophilia hypothesis. Theoretically, human perceptions of nature may be classified into nine different types: utilitarian, naturalistic, scientific, aesthetic, symbolic, humanistic, moralistic, dominionistic and negativistic (Kellert 1993). These nine perspectives may be useful for capturing social perceptions about exotic invasive plant species.

Biophilia has important influence in problem solving for biodiversity conservation (Simaika & Samways 2010). Social perception may indicate either social acceptance of invasive species management or potential conflict of interest that may inhibit the management of invasive species (Shackleton et al. 2016), particularly for regions with limited and short history of management effort in invasive species. Identifying the perception types will complement planning of invasive species management because management implementation will involve stakeholders who have their own particular individual or communal perceptions of exotic invasive species. If decision-makers are able to understand the perception types of different stakeholders, it may create new opportunities to engage with the community to achieve management goals. For example, social perception becomes more crucial for management of exotic species that have benefits for local communities (Kull et al. 2015). Socio-economic aspects of perception should not be excluded from management of exotic species, but should be combined with ecological perspective. This may in turn lead to greater social acceptance of management plans and their implementation.

In this study, stakeholders' perceptions of invasive plant species were explored. The stakeholders were from Indonesian botanical gardens which are considered as both a source of and a pathway of exotic plant species invasion (Hulme 2015). The objectives of this study were to examine: (1) the dominant biophilia-based perception types exhibited by the staff of botanical gardens in relation to the exotic plant species in the gardens and (2) whether these perception types correlated with different management level positions, education background, gender and other possible factors included in the study. This study discussed how the outcomes might contribute to exotic invasive species management plan construction and implementation.

MATERIALS AND METHODS

Locations

Four botanical gardens, namely, Cibodas Botanical Gardens (CBG), Bali Botanical Gardens (BBG), Baturraden Botanical Gardens (BRBG) and Kuningan Botanical Gardens (KBG) were used in this study for two main reasons. First, these botanical gardens hold exotic species in their living collections. Second, all these botanical gardens are adjacent to native forest ecosystems that may be exposed to invasion risk from the exotic collections in the botanical gardens.

Biophilia-based perception types

Questionnaires (Appendix 1) with close-ended questions and a Likert scale (1 to 5) were used to capture biophilia-based perception data from the staff of the botanical gardens (Kellert 1993). Perception types examined in this study were: utilitarian, dominionistic, scientific, moralistic, negativistic and humanistic. Naturalistic, aesthetic and symbolic perspectives were omitted from this study because of several reasons. First, naturalistic may intersect with scientific types because the naturalistic attitude involves intense curiosity (Wilson 1984). Second, I considered symbolistic, which was the attitude of using invasive exotic plant species in metaphorical expression (Wilson 1984), as negligible. Third, aesthetic might also overlap with utilitarian because many exotic species were utilised as ornamental plants. Thus, categories which were expected to be redundant were omitted to reduce the burden on the participants. In the questionnaire, there were three questions for every perception type

(a total of 18 questions, Appendix 1). Questions were obtained from relevant literature (Rauwald & Moore 2002, Thompson & Mintzes 2002, Barney et al. 2005, Lukas & Ross 2005) and were modified to meet the survey objectives of capturing perceptions of exotic invasive plant species. These 18 questions were randomly ordered in the questionnaire to avoid potential biases arising from question sequence. Since each perception type assessed in this study was captured with three questions, the Spearman rank correlation was examined between data from the same typology group. The principal component analysis was conducted to examine visually the groupings of different perception types in a reduced dimensional space.

Pairwise comparison process was applied to the Likert scale data following a method suggested by Delavari-Edalat and Abdi (2010). Normalised and weighted values of the Likert scores were used as input data for the pairwise comparisons. It was assumed that distances between consecutive Likert score values were consistent. Information on respondent's job position, educational background, gender, age and work experience was obtained from demographic questions (Figure 1).

Quantifying the dominance of biophilia-based perceptions: relative preference scores

The dominance of a biophilia-based perception type was quantified as the ratio of the preference score of that particular perception type to the total preference score for all perceptions (Delavari-Edalat & Abdi 2010). Firstly, questionnaire results were compiled in a table where rows were typologies, columns were Likert categories (strongly agree, agree, neither agree nor disagree, disagree, and strongly disagree), and cells contained counts of responses. For rows that belonged to the same perception type, the counts in all cells were then pooled and the proportion was scaled between 0 and 100 by dividing the pooled value in every cell by the number of samples times 3 because there were three questions for every perception type (Delavari-Edalat a& Abdi 2010) (Appendix 1), using equation 1:

$$Nd = (x/3n) \times 100 \quad (1)$$

where Nd = proportion data, x = pooled count responses data for each perception type in each Likert category response and n = total number of respondents. The proportion data were converted to preference scores by weighting the values based on the response categories using equation 2:

$$\sum_{i=1}^{n} P(x_i)\, x_i \quad (2)$$

where $P(x_i)$ = the probability of proportion data value in a cell (cell value/100) and x_i = 5 for strongly agree, 4 = agree, 3 = neither agree nor disagree, 2 = disagree and 1 = strongly disagree.

1. Gender ☐Male ☐Female

2. Age ☐18-20 ☐21-30 ☐31-40 ☐41-50 ☐51-60

3. Educational Background ☐Elementary, Junior or High School ☐Undergraduate ☐Postgraduate

If Undergraduate or Postgraduate, what discipline?

☐Biology, Agriculture, Forestry or other Sciences

☐Economy

☐Social and Psychology

☐Management

☐Engineering

☐Others

4. Position in Botanic Gardens ☐Management ☐Researcher ☐Gardener / Worker

5. Working Experience (years) ☐< 5 ☐5-10 ☐11-20 ☐> 20

Figure 1 Demographic questionnaire used for the study

Preference score for each perception type was obtained by summing all values within that perception type. Relative preference score (as percentage) of a particular perception type is simply the ratio of the preference score of that perception type and the total preference score of all perception types (total data column). Relative preference scores were considered as quantitative measures of perception type dominance.

Similar calculations were also conducted for data that were categorised based on demographic groups. These demographic grouping categories were: age (< 40 vs > 40 years old), work experience (< 10 years vs > 10 years), gender (female vs male), education (high school vs graduate), and position (gardener/worker vs researcher/manager).

Chi-square tests were also conducted for every perception type group (consisting of three questions for each type as in Table 1) to test whether respondents' behaviour was different in relation to the biophilia-based perception. The hypotheses were: (1) H_0, there was no association between biophilia-based perception and respondent's behaviour, and (2) H_1, there was association between biophilia-based perception and respondent's behaviour.

RESULTS AND DISCUSSION

Respondents

A total of 200 questionnaires were distributed and there were 168 respondents. The largest number of respondents was from CBG which had the largest population of garden employees, followed by BBG (Figure 2). Most respondents were males with high school qualifications. The age of respondents and their number of years of work experience were relatively varied.

Correlation between questions within typologies

Correlation between questions within perception types were generally weak. The strongest correlation was between questions about dominionistic perception type with 0.663 as the largest Spearman rank correlation value (Table 1). Principal component analysis on all questions showed that there were no clear differentiations or clustering between different perception type answers from all respondents (Figure 3). The only two noticeable clusters were of scientific and dominionistic data.

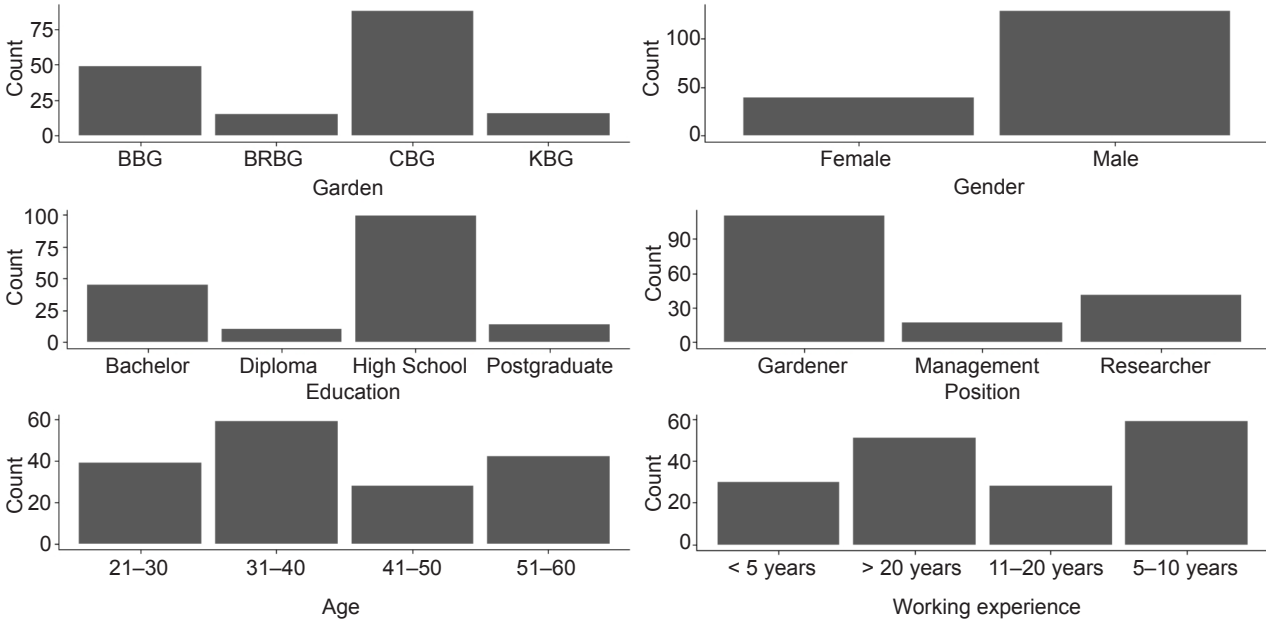

Figure 2 Number of respondents based on demographic categories (N = 168); BBG = Bali Botanical Gardens, BRBG = Baturraden Botanical Gardens, CBG = Cibodas Botanical Gardens and KBG = Kuningan Botanical Gardens

Table 1 Spearman rank correlation test results for questions

Compared questions	ρ (Spearman)
ut-1 vs ut-2	0.513
ut-1 vs ut-3	0.517
ut-2 vs ut-3	0.552
do-1 vs do-2	0.663
do-1 vs do-3	0.244
do-2 vs do-3	0.071
sc-1 vs sc-2	0.580
sc-1 vs sc-3	0.338
sc-2 vs sc-3	0.494
mo1 vs mo-2	0.140
mo-1 vs mo-3	0.429
mo-2 vs mo-3	0.217
ne-1 vs ne-2	0.539
ne-1 vs ne-3	-0.067
ne-2 vs ne-3	0.038
hu-1 vs hu-2	-0.185
hu-1 vs hu-3	0.088
hu-2 vs hu-3	0.009

Questions compared in this table refer to questions in Appendix 1; ut = utilitarian, do = dominionistic, sc = scientific, mo = moralistic, ne = negativistic and hu = humanistic

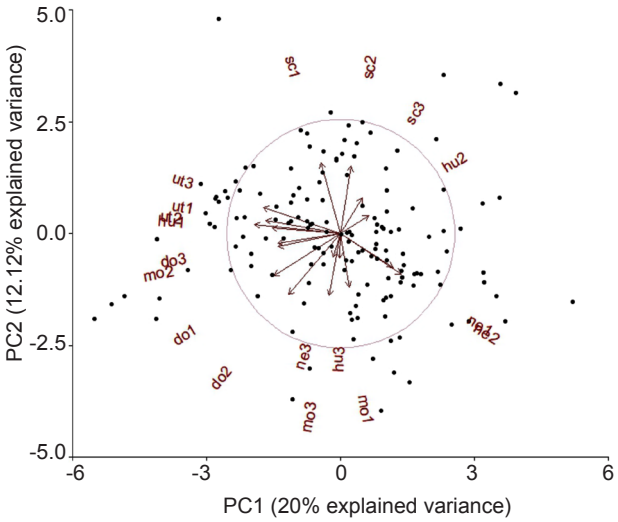

Figure 3 Principal component (PC) analysis biplot results for all 18 perception type answers in the questionnaire; ut = utilitarian, do = dominionistic, sc = scientific, mo = moralistic, ne = negativistic and hu = humanistic; PC1 and PC2 explained 20 and 12.2% of total variation respectively

Biophilia-based perception types

Most of the responses were in the strongly agree, agree, and neither agree nor disagree categories while there were only a few responses in strongly disagree and disagree across all perception types (Appendix 1). The proportion data for all perception types (Table 2) were obtained by implementing equation 1.

The χ^2 test results for every typology suggest that the typology answers (strongly agree, agree, neither agree nor disagree, disagree or strongly disagree) in the questionnaire were not independent of the respondents' behaviour (Table 3, $p < 0.05$ for all perception types). This was because all χ^2 values for all perception types were larger than 15.51, which was the critical value for df = 8 and significance level = 0.05.

The preference score calculation results are presented in the Table 4. Across all demographic category groupings, dominionistic had the highest relative preference score, meaning this perception type was the most pervasive among respondents (Table 4). However, there was no clearly dominant perception type and there was little variation in the relative preference scores across perception types. These facts explained why there was no clear clustering pattern in the principal component analysis biplot (Figure 3).

Biophilia-based perceptions and invasive exotic species management

The fact that there was no clearly dominant perception type preferred by respondents was an interesting finding. This showed that the full range of perception types included in this study should be considered when developing socially-acceptable management plans for exotic invasive species in Indonesia. Social perceptions of the elements of biological systems have been shown to be important when developing natural resources related management policies in other contexts. For instance, consideration of residents' perceptions is particularly important for wildlife conservation management in urban contexts in Australia (Daniels & Kirkpatrick 2011, Fitzgibbon & Jones 2006). Likewise, visitors' perceptions of biodiversity explain visitors' attraction towards national parks (Siikamäki et al. 2015).

Stakeholders' perceptions need to be carefully considered to achieve social acceptance of invasive exotic plant species management in a conservation context. Importantly, both negative and positive impacts of exotic species should be considered when establishing adaptive conservation management plans (Prévot-Julliard et al. 2011). Successful invasive exotic species management needs a flexible approach that includes socio-economic involvement (Prévot-

Table 2 Proportion of pooled data (value between 0–100) from questionnaire

Typology	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Utilitarian	4.365	54.365	25.595	14.286	1.389
Dominionistic	11.706	77.183	8.730	1.786	0.595
Scientific	8.730	67.262	18.651	4.762	0.595
Moralistic	14.484	56.151	19.841	8.333	1.190
Negativistic	10.317	39.484	29.762	18.651	1.786
Humanistic	4.960	54.563	34.127	5.952	0.397

Table 3 Chi square test results for all biophilia data from all perception types

Parameter	Utilitarian	Dominionistic	Scientific	Moralistic	Negativistic	Humanistic
χ^2	68.975	19.514	34.471	182.19	184.28	17.677
df	8	8	8	8	8	8
p value	7.859×10^{-12}	0.0123	3.338×10^{-5}	2.2×10^{-16}	2.2×10^{-16}	0.0238

Table 4 Relative preference score (%) for all perception types

Typology	All data	Demographic category									
		Gender		Age		Experience		Education		Position	
		Male	Female	< 40 years	> 40 years	< 10 years	> 10 years	High school	Graduate	Gardener	Manager
Dominionistic	18.136	18.358	18.081	18.071	18.227	18.249	18.009	18.068	18.235	18.264	18.070
Scientific	17.276	17.506	17.239	17.436	17.051	17.274	17.278	17.200	17.387	17.758	17.028
Moralistic	17.077	16.542	17.264	17.080	17.073	17.086	17.067	17.215	16.875	16.560	17.343
Humanistic	16.317	16.289	16.311	16.321	16.311	16.350	16.279	16.514	16.028	15.895	16.534
Negativistic	15.412	15.989	15.117	15.640	15.091	15.683	15.107	14.915	16.139	16.294	14.957
Utilitarian	15.783	15.317	15.989	15.454	16.246	15.358	16.260	16.088	15.337	15.229	16.068
Total	100	100	100	100	100	100	100	100	100	100	100

All data refers to relative preference scores from total respondents without considering their demographic categorisation

Julliard et al. 2011). Potential conflicts may arise if social considerations are not part of the plan. For example, conflict of interest may become a barrier to the implementation of invasive species management (Shackleton et al. 2016).

In general, the dominionistic perspective dominated the social perception of botanical gardens staff towards exotic invasive plant species. While there was only minor variation in perception type dominance across demographic factors, dominionistic and scientific were the most prevalent perception types across the different factors. These findings indicated that the desire to manage or 'to rule' and curiosity to learn about exotic species were important motivations behind biophilia-based perceptions in Indonesian botanical gardens. Further study contrasting the perception typology of other stakeholders (such as local communities adjacent to botanical gardens) with botanical gardens stakeholders will contribute to more comprehensive understanding of stakeholders' perception of exotic invasive plant species. These perception typology data may provide reliable estimates of general social perceptions of exotic invasive species. This valuable information may help to avoid or minimise conflict of interests among stakeholders in exotic invasive species management. The result of this study can also be applied to global application when appointing staff near forest area for invasive species management.

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Appendix 1 Questionnaire used in the study and the total number of respondents who answered that response according to the particular score

	Question	Strongly agree (5)	Agree (4)	Neither agree nor disagree (3)	Disagree (2)	Strongly disagree (1)
1	Preventing revenue loss is more important than preventing exotic species to become invasive (ut-1)	6	62	65	32	3
2	Exotic species should not be eradicated or contained if managing them makes us lose money (ut-2)	8	83	40	35	2
3	Exotic plant species should not be eliminated from native forest because multiple uses of exotic species provide opportunity to gain money (ut-3)	8	129	24	5	2
4	There is nothing wrong with using exotic plant species for medicinal, ornamental or food consumption purposes (do-1)	27	132	7	1	1
5	I enjoyed the beauty of exotic ornamental plant when it was broadcasted in TV commercial or TV programs (do-2)	11	130	23	4	0
6	Using exotic plant species to attract ecotourism is not wrong (do-3)	21	127	14	4	2
7	I like to learn about the different kinds of exotic plants (sc-1)	11	97	48	9	3
8	I would like to study about the competition between exotic plant species and native plant species in tropical forest (sc-2)	23	113	21	11	0
9	I was fascinated by the ability of exotic plant species to adapt to their new environment (sc-3)	10	129	25	4	0
10	I considered the beauty of exotic plant as part of the beauty of nature (mo-1)	16	128	18	6	0
11	All life in nature including exotic invasive plant species has a right to exist (mo-2)	45	109	12	2	0
12	Eradicating exotic invasive plant species is cruel (mo-3)	12	46	70	34	6
13	I was appalled by the potential negative impact of exotic invasive species toward species extinction (ne-1)	30	89	37	12	0
14	I worried that the exotic plant species will become invasive (ne-2)	20	95	40	10	3
15	I think exotic plant species are poisonous (ne-3)	2	15	73	72	6
16	When I see ornamental exotic plant species, I feel relaxed and happy (hu-1)	9	81	61	17	0
17	I like exotic plant species (hu-2)	6	100	59	3	0
18	Exotic ornamental plants should be appreciated because they are beautiful (hu-3)	10	94	52	10	2

Questions are related to the perception typology of biophilia framework; ut: utilitarian, do: dominionistic, sc: scientific, mo: moralistic, ne: negativistic and hu: humanistic